# 7 Anterior Cervical Diskectomy and Fusion Ⓐ

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## Introduction and Background

- In the early 1960s, Cloward and Robinson popularized the anterior approach to the cervical spine for the treatment of diskogenic disease.

### Alternate Procedures

- Posterior laminotomy
- Posterior foraminotomy
- Laminoplasty
- Cervical laminectomy with or without fusion
- Anterior cervical diskectomy without fusion

### Goals

- Decompress the cervical cord and exiting nerve roots
- Resect herniated disks
- Create a solid fusion construct
- Maintain spinal alignment

### Advantages

- Complete diskectomy will allow an increased fusion rate.
- Better disk space distraction and better access to the neural foramina bilaterally
- Address anterior pathology directly from anterior route under direct vision
- Avoid the need for prone position especially in older patients with comorbidities

### Indications

- Cervical radiculopathy caused by herniated disks, spondylotic spurs, or osteophytes (▶ Fig. 7.1)
- Single-level disk disease
- Cervical myelopathy caused by herniated disks, spondylotic spurs, or osteophytes
- Multiple-level spondylitic radiculopathy

### Contraindications

- Patients not suitable for surgical intervention due to significant comorbidities such as poor cardiopulmonary status or bleeding disorders.
- Primarily posterior pathology such as posterior compression due to ligamentous infolding
- Patients not willing to sustain risks on an anterior cervical approach (e.g., professional singers concerned about vocal cord function)

## Operative Detail and Preparation

### Preoperative Planning and Special Equipment

- Preoperative complete physical and neurologic examinations
- Appropriate imaging studies to understand the maximum point of neural compression
- Plain radiographs, magnetic resonance imaging (MRI), computed tomography (CT) scan, and CT myelogram if indicated can be obtained.
- Operative microscope, high-speed drill, cervical bone curettes, adequate self-retaining cervical retractors (TrimLine™ Medtronic Inc., Memphis, TN; Shadowline™, V. Mueller & Co., Eisenberg am Pfalz, Germany; or Caspar™ cervical retractor, Aesculap, Inc., Center Valley, PA), cervical cages or bone allograft (unless an iliac crest autograft fusion is contemplated), cervical plating system
- Intraoperative monitoring: Electromyography (EMG), somatosensory evoked potentials (SSEPs), and/or motor evoked potentials (MEPs). Awake fiberoptic intubation may be performed on myelopathic patients.
- Prophylactic antibiotics are administered after induction of general anesthesia.

### Expert Suggestions / Comments

- The approach may be performed from either the right or left side according to the surgeon's preference. Although a right-handed surgeon will have more ease approaching the spine from the right side, in cases where vocal cord function preservation is

**Fig. 7.1** Sagittal T2-weighted magnetic resonance image of patient showing prominent central disk herniation at the C6–C7 level, resulting in compression of the spinal cord.

of great concern, or where the pathology is primarily on the right side of the spine, it may be preferable to approach from the left side (so as to avoid the recurrent laryngeal nerve).

- An approach from the right side risks injury to the recurrent laryngeal nerve. It is usually easier to address pathology on the contralateral side of the spine given the slightly oblique line of sight under the microscope. If the patient has had a previous surgical exposure, the approach is typically performed from the same side. Patients with paralyzed vocal cords are approached from the side of paralysis. A left-side approach especially to the lower cervical spine carries the risk of injury to the thoracic duct.
- For multilevel disease, all involved interspaces should be exposed at the same time. The less-accessible disk space (most stenotic or most difficult to access) should be decompressed before proceeding to the next. Bone grafts should be placed sequentially on all levels, followed by instrumentation.

## Key Steps of the Procedure

### Positioning and Anesthesia

The patient is placed in the supine position. The neck is positioned in slight extension with a roll placed vertically between the scapulae. The shoulders are taped down for better visualization of the lower cervical spines. Alternatively, the wrists may be wrapped with soft wraps and extensions from the wrist wraps are used to pull down to better visualize the lower cervical spine on plain X-ray views. Extension of the neck should be done under neurophysiologic monitoring, as extension may have an impact on the spinal cord.

For a single level, a transverse incision following a skin crease at a previously chosen level as determined by the lateral cervical X-ray is performed (▶ Fig. 7.2). Alternatively, a longitudinal incision along the anterior border of the sternocleidomastoid can be made for single or multiple levels. Landmarks include the angle of the mandible indicating the level of the C2 body, the hyoid bone at the level of C2–C3 and the cricoid cartilage at the level of C4–C5. Once the skin incision is performed, the platysma muscle is then sharply incised transversely across the entire width of the incision. The platysma muscle is elevated at both wound margins and blunt dissection proceeds immediately beneath this muscle. Subplatysmal dissection is imperative if more than one vertebral level is being exposed. The cervical fascia is opened vertically just anterior to the sternocleidomastoid muscle. It is very important to find the plane between the sternocleidomastoid overlapping the carotid sheath laterally, and the strap muscles medially. Dissection is carried down through that plane. Both sharp and blunt dissections are used to separate the soft tissue. The carotid sheath is retracted laterally and the trachea and esophagus medially. Once the prevertebral soft tissue has been opened, the longus colli muscles become visible overlying the anterior longitudinal ligament and the vertebral bodies. With handheld retractors, the carotid sheath is held laterally, and the esophagus and trachea medially (with the aid of an assistant). The prevertebral fascia is opened at the midline. Vertebral bodies and intervertebral disks are then easily palpable (▶ Fig. 7.3).

The level thought to be appropriated is selected and with further dissection exposed. The appropriate level is then marked

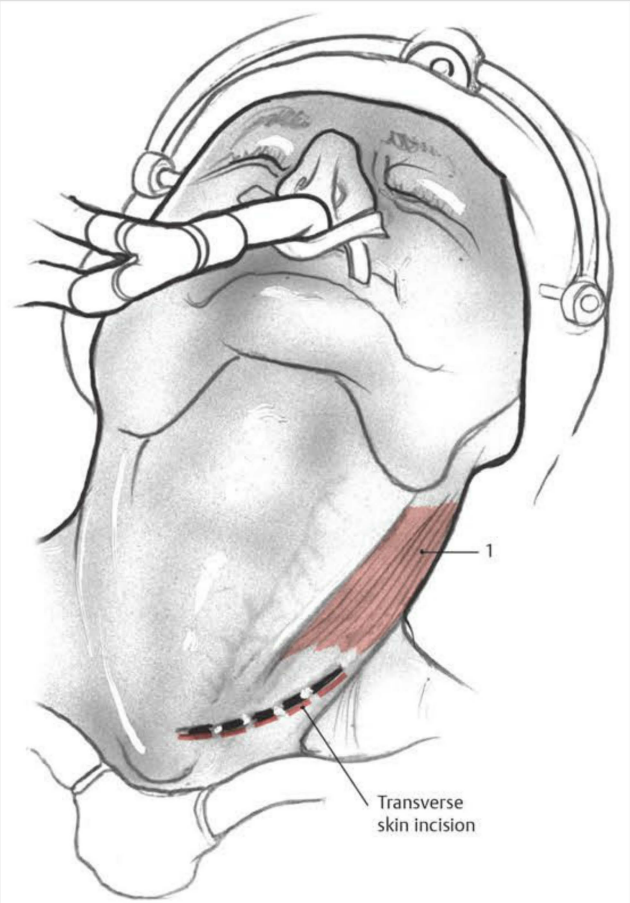


**Fig. 7.2** Transverse incision following a skin crease from the medial margin of the sternocleidomastoid muscle to the midline. The incision is centered over the level of interest previously located with anatomic landmarks and later confirmed with fluoroscopy. 1. Sternocleidomastoid muscle.

with a spinal needle inserted to a depth of ~1 cm and verified with lateral cervical fluoroscopy. The longus colli muscles are stripped laterally from the anterior surface of the two vertebral bodies adjacent to the interspace that will be explored. A self-retaining anterior spinal retractor (TrimLine™ or Shadowline™) is then inserted and the longus colli retracted. The teeth of the lateral retracting blade should be inserted into the longus colli muscles and must not be displaced throughout the remainder of the operation. The anterior longitudinal ligament is dissected off the vertebrae. A window is made into the disk interspace with #11 blade and should be carried laterally as far as the retractor permits. A pin retractor system is then inserted in the adjacent vertebral bodies (Caspar™ cervical retractor). The vertebral bodies are distracted gently using the pin distractor.

A diskectomy begins with a rectangular incision in the annulus fibrosus. The superficial disk material is resected with cervical curettes and interspace rongeurs (▶ Fig. 7.4). For the deeper portion of the diskectomy, an operating microscope is used. All bony disk material must be removed from the anterior cervical nerve root without disturbing the vertebral artery. The posterior longitudinal ligament is removed across the entire width of the

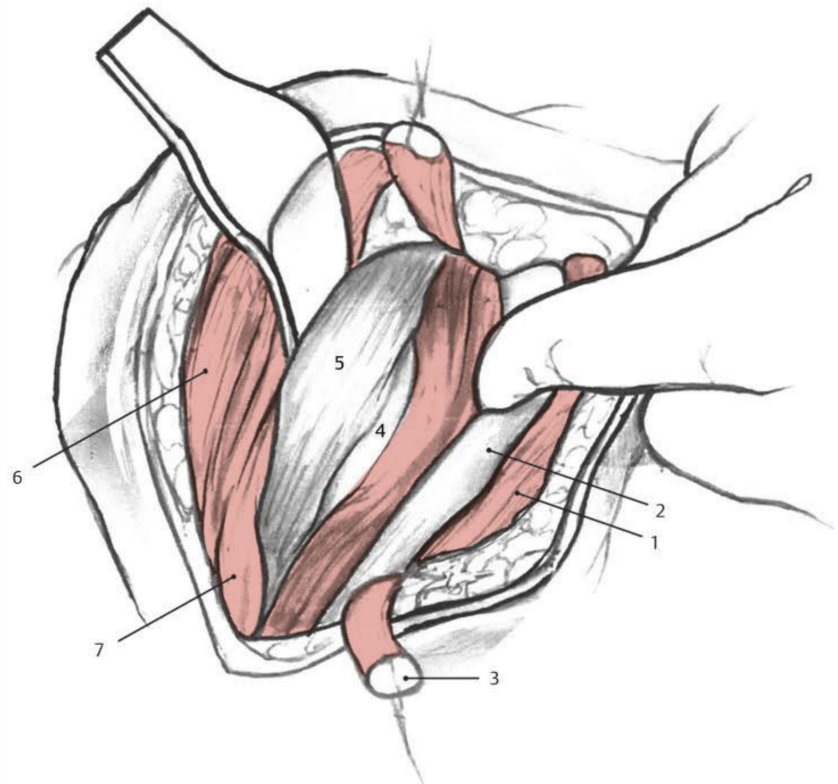


**Fig. 7.3** Exposure of the prevertebral fascia after platysma incision and dissection along the avascular plane through the cervical fascia. 1. Sternocleidomastoid muscle; 2. carotid sheath; 3. omohyoid muscle; 4. longus colli muscle; 5. anterior longitudinal ligament; 6. anterior strap muscles; 7. esophagus.

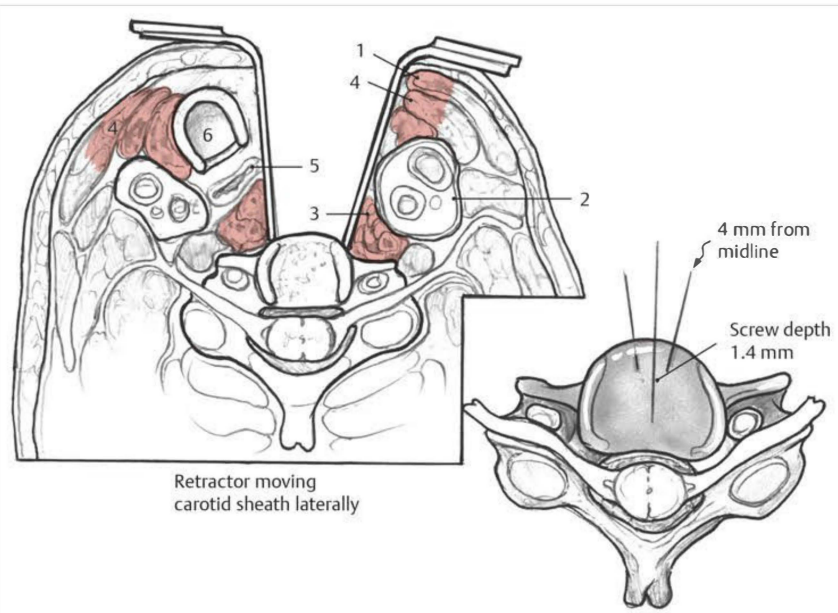


**Fig. 7.4** After application of self-retaining retractor to displace the longissimus colli and distraction of the vertebral bodies to enhance access to the disk space, the disk is removed with rongeurs and curettes. Axial views of the spine showing retractor placement and soft tissue structures (*left*) as well as planned screw trajectory and depth (*right*). 1. Sternocleidomastoid muscle; 2. carotid sheath; 3. longus colli muscle; 4. omohyoid muscle; 5. esophagus; 6. trachea.

interspace. Removal of the ligament is an important part of each anterior cervical fusion. Extruded fragments of the disk material or redundant ligaments are often found to be a source of stenosis and are removed during this part of the operation. Each neural foramen is explored once again to ensure that both nerve roots have been decompressed, using a right-angle nerve hook. If still stenotic, they may be decompressed using Kerrison rongeurs.

Once the diskectomy and appropriate bony decompression has been completed, fusion can proceed. Adjacent vertebral body endplates are drilled along the disk space to promote fusion and to lock the graft into position. The height of the disk space is obtained by measurement with an interbody spacer. A structural bone graft or cage spacer of adequate measurement is then inserted using mallet and tap (▶ Fig. 7.5). The graft may be packed with some bone matrix or other bone substitute to promote

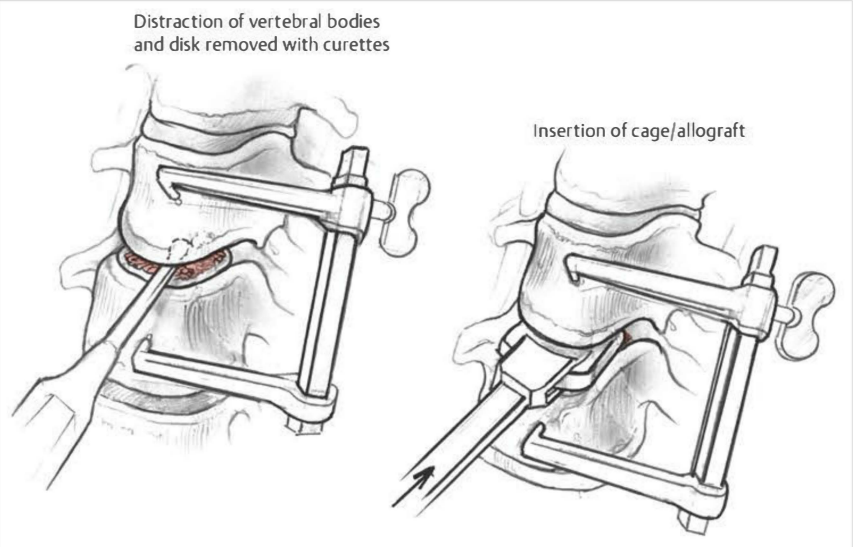


**Fig. 7.5** The cage that is deemed the right height to reestablish foraminal height and promote lordosis is placed into the disk space after packing with bone graft or bone substitute.

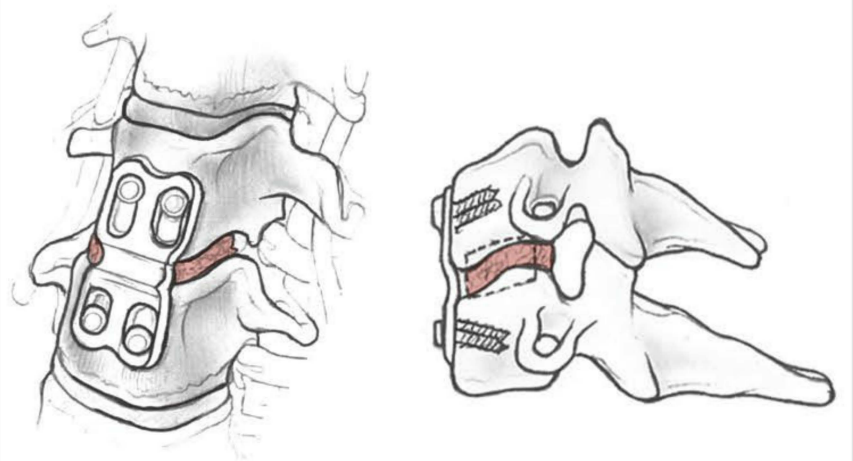

**Fig. 7.6** Anterolateral and sagittal view of the plate in situ over the front of the anterior vertebral bodies, flush with the bone.

fusion. Distraction is released and fluoroscopic radiographs obtained to verify adequacy of the arthrodesis.

An anterior cervical plate (made from titanium or other resorbable plastic polymer) of adequate length is measured to span the fusion area. Appropriate plate holes are made just past the endplate and centralized equidistantly from the midline. One may drill the anterior edge of the endplate for better fitting of the plate. The plate is temporarily fixed with pins and position verified by fluoroscopy prior to screw placement. Drill holes for the screws are made by using the manual drill provided in the cervical plating set to appropriate length, which is usually 12–16 mm (obtained from the lateral X-ray). Screw trajectory should be aimed divergent and away from the disk space (i.e., upper screws are angled rostrally and lower screws caudally). The screws are then locked to the plate after being tightened, using the provided locking mechanism. Final construct position is verified under fluoroscopy (▶ Fig. 7.6).

The self-retaining retractors are subsequently removed. The patient's carotid pulse is verified and superficial bleeding is controlled with bipolar cauterization. After copious irrigation with antibiotic saline solution, the platysma and subcutaneous tissues are reapproximated with simple interrupted 3-0 Vicryl sutures. The skin is approximated with a running 4-0 subcuticular resorbable suture over a subplatysmal drain.

## Avoidances / Hazards / Risks

- The endotracheal cuff should be intermittently decompressed to reduce pressure on the recurrent laryngeal nerve once the cervical retractor is in place.
- When elevating the longus colli muscle and using the Bovie cautery, one should be cognizant of the proximity of the carotid arteries as well as the sympathetic fibers, which may be injured in that process.
- To diminish the incidence of nonunion, it is important to refrain from using bone wax along the endplates of the interspace to be fused.
- It is important to maintain accurate localization of the midline; in severely degenerative spines, sometimes osteophytes may make it difficult to determine exactly where the midline is located. This may be performed by obtaining anteroposterior (AP) X-rays of the cervical spine, once the exposure of the anterior aspect of the vertebral bodies is completed.

- One should pay particular attention to the foramen ipsilateral to the side of the decompression as the natural tendency is to complete the better decompression along the foramen of the opposite side.
- Drilling of the posterior edge of the vertebral body should be carried from one uncovertebral joint to the other to achieve adequate decompression.

## Salvage and Rescue

- Cerebrospinal fluid leaks may be challenging to address in anterior cervical approaches. If possible, they should be closed primarily. Otherwise, a dural patch may be used such as locally harvested fat or muscle or alternatively onlay synthetic dural membranes. Fibrin glue can be placed on top of a small piece of absorbable gelatin sponge (Gelfoam™, Pfizer Inc., New York, NY) following which the bone graft is placed. One should avoid placing a subplatysmal drain at the end of the case. A lumbar drain may be used and left for a few days postoperatively, while the head is elevated, if there is concern of leakage through the skin. The skin closure should be reinforced with skin glue.
- Injury to the vertebral artery, although rare, may be challenging. It is usually avoided by not extending the exposure too laterally and by a careful study of the preoperative imaging. If it occurs, pressure may be applied with absorbable gelatin sponge or cottonoids. If bleeding persists, then further exposure may be required by taking off more bone laterally and visualizing the site of bleeding. One may need to harvest a small piece of muscle graft to use as a plug over the opening. The anesthesiologist should be aware that bleeding is occurring so as to ensure that donor blood is ready for transfusion. To better expose the vertebral artery, the longus colli muscle may have to be dissected laterally on either side of the artery. The segment of vertebral artery involved may have to be clipped in cases where bleeding is intractable. A postoperative angiogram is then obtained to ascertain flow along the contralateral side.

# Outcomes and Postoperative Course

## Postoperative Considerations

- To promptly react in cases of postoperative airway-related complications, all patients are routinely watched overnight in the monitored unit.
- As soon as the patient is discharged from the ward, AP and lateral cervical spine radiographs are obtained to ascertain implant and graft position (▶ Fig. 7.7, ▶ Fig. 7.8).
- All patients are encouraged to ambulate as soon as they have recovered from the anesthesia.
- Drains are removed on the first postoperative day.

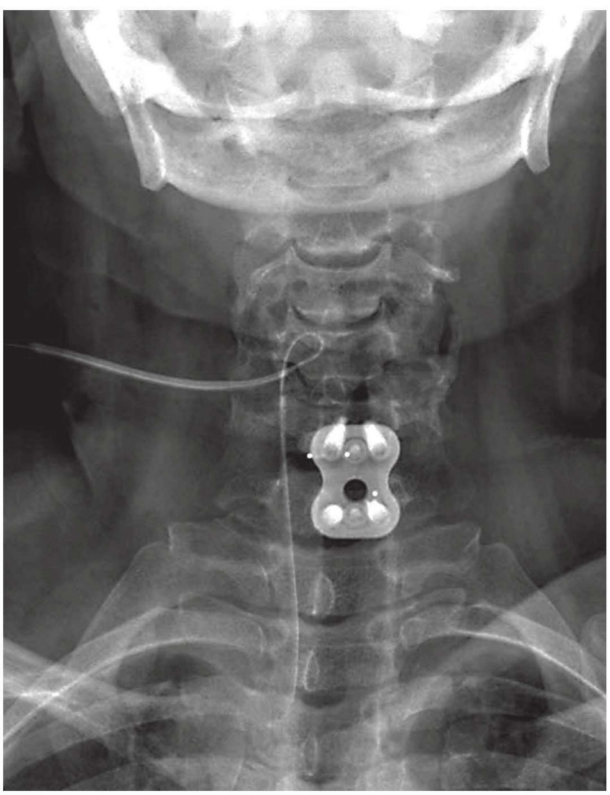

**Fig. 7.7** Postoperative cervical spine posteroanterior radiograph, showing single-level anterior cervical diskectomy without fusion with plate fixation.


**Fig. 7.8** Postoperative cervical spine lateral radiograph showing C6–C7 fusion. Notice the position of the cage, and how there is no evidence of retropulsion.

- Most patients are discharged from the hospital 1 day after the operation.

## Outcomes

- Anterior cervical diskectomy is successful in relieving arm pain related to radiculopathy in more than 90% of patients.
- Arm weakness and numbness may persist for weeks to months.
- Neck pain is relieved in 70–80% of patients where there is only one degenerated disk and facet joints are not involved.
- In general, patients with arm pain benefit more from anterior cervical diskectomy and fusion (ACDF) than those with neck pain.
- Patients are encouraged to have a positive attitude and to diligently perform physical therapy exercises.

## Complications

- Voice hoarseness
- Swallowing difficulties
- Fusion failure
- Implant fracture
- Screw migration
- Bone graft migration
- Transitional syndrome (adjacent-segment disease)
- Nerve damage or persistent pain
- Hematoma
- Infections
- Esophageal injury
- Tracheal injury

## References

[1] Agrillo U, Mastronardi L, Puzzilli F. Anterior cervical fusion with carbon fiber cage containing coralline hydroxyapatite: preliminary observation of 45 consecutive cases of soft-disc herniation J Neurosurg 2002; 96: 273–276

[2] Bolesta MJ, Gill K. Acute neck pain and disk herniation. In: Spivak JM, Connolly PJ. Orthopedic Knowledge Update, Spine 3. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2006:227–234

[3] Law MD, Jr, Bernhardt M, White AA, III. Evaluation and management of cervical spondylotic myelopathy. JBJS Am. 1994; 76: 1420–1433

[4] Riew KD, Buchowski JM, Sasso R et al. Cervical disc arthroplasty compared with arthrodesis for the treatment of myelopathy. JBJS Am. 2008; 90: 2354–2364

[5] Xie JC, Hurlbert RJ. Discectomy versus discectomy with fusion versus discectomy with fusion and instrumentation, prospective randomized study. Neurosurgery 2007; 61: 107–116

[6] Cloward RB. The anterior approach for removal of ruptured cervical disks. J Neurosurg 1958; 15: 602–617

[7] Robinson RA, Walker AE, Ferlic DC et al. The results of anterior interbody fusion of the cervical spine. J Bone Joint Surg Am 1962; 44: 1569–1587